**Reviews of scientific publications**

**of Assoc. Prof. Dr. Tatyana Stefanova Petrova**
**in English**

**1. Petrova, T.**, Darakchiev, S., Vaklieva-Bancheva, N., Popov, R., "Analysis, Quantitative Estimates and Methods for Reducing of the Maldistribution Created from Gas Distribution Devices for Column Apparatuses", *Chemical Engineering Transactions*, 35, 1165-1170 **(2013)**. ISSN:2283-9216, https://www.aidic.it/cet/13/35/194.pdf , **SJR(2013)=0.385 , Q2 (Scopus)**

Providing of good initial radial distribution of gas phase is of significant importance for efficiency of column apparatuses. The aim of the present work is to analyze and evaluate gas flow maldistribution in different types of gas distributing devices (GDD) and respectively their efficiency, based on experimental data for the output velocity profile. The experimental data capture measuring of velocity profile for two construction types GDD – with circular and local tube gas feed. For both several additional modifications are also investigated – with adding the redistribution grids and gauzes, the empty section after the GDD, in the presence of water mirror under the GDD, etc. By the help of MATHCAD, six types of quantitative estimations of GDD maldistribution are determined and then their sensibility toward several factors such as the type of GDD, the initial gas flow velocity, the number and dimension of measuring cells on the column cross-section, the measurement error and so on, are investigated. It is found that only two of the quantitative maldistribution estimations take into account the formation of maldistribution clusters, which deteriorated the efficiency of the processes in the column. A novel method for quantitative determination of these clusters as well as for identification of the zones at column cross-section, in which they appeared, has been developed. It is established that the measurement error and the dimension of measuring cell deeply influence as on the number, the area and spatial distribution of these zones on the cross-section, as well as on the values of maldistribution estimates. It is shown that with adding of supplementary redistribution devices like grids and gauzes, the GDD's maldistribution can be reduced about 3 times, without significant increasing of pressure drop.

**2. Petrova, T.,** "Influence of hydrodynamic conditions on the process of heat and mass transfer between the flow and Raschig ring catalyst", *Journal of Chemical Technology and Metallurgy*, 49, 5, 442-446 **(2014)**. ISSN:1314-7471 (Print)/ 1314-7978 (Online), https://journal.uctm.edu/node/j2014-5/ST-3.pdf , **SJR(2014)=0.205, Q3 (Scopus)**

The influence of hydrodynamic conditions on heat and mass transfer for the process of oxidation of $SO_2$ to $SO_3$ at single catalyst pellet - Raschig ring, is investigated. A set of numerical experiments have been carried out for two different hypotesis of catalyst surface accessibility. A

comparison of the obtained results for the temperature and conversion distributions in radial and axial directions in the catalyst pellet is made.

**3.** **Tatyana Petrova**, Natasha Vaklieva-Bancheva, Simeon Darakchiev, Roman Popov, "Quantitative estimates of gas maldistribution and methods for their localization in absorption columns", *Clean Technologies and Environmental Policy*, 16, 7, 1381-1392 **(2014)**. Electronic ISSN:1618-9558/Print ISSN: 1618-954X, https://doi.org/10.1007/s10098-014-0771-2 , **IF(2014)=1.934, Q2 (Web of Science)**

In the present work, we carry out evaluation of gas flow maldistribution in different types of gas distributing devices (GDD) and packings by using experimental data for the output velocity profiles for both the absorption pilot column and industrial column. Two GDD construction types—with circular and with local tube gas feed, together with their modifications—are investigated. Two pilot columns—with random packing RSRM 1.500 and with structured ceramic Honey-comb packing, and one industrial contact economizer with Honey-comb and inclined rings—have been studied. Six types of quantitative estimations of GDD and packings maldistribution are determined by the help of MATHCAD. Then, their sensitivity toward several factors, such as the type of GDD and packing, the initial gas flow velocity, the number and dimension of measuring cells on the column cross-section, the measurement error, and so on, is investigated. It is found that only two of the quantitative maldistribution estimations take into account the formation of maldistribution clusters, which deteriorates the uniform gas distribution. A novel method for quantitative determination of these clusters and also for identification of the zones at column cross-section, in which they appeared, has been developed. It is established that the measurement error and the dimension of measuring cell deeply influence the number, the area, and spatial distribution of these zones on the cross-section, as well as the values of maldistribution estimates.

**4.** Daniela Dzhonova-Atanasova**,** **Tatyana Petrova**, Krum Semkov**,** Simeon Darakchiev**,** Konstantina Stefanova**,** Svetoslav Nakov**,** Roman Popov, "Experimental Investigation of Liquid Distribution in Open Structure Random Packings as a Basis for Model Refinement", *Chemical Engineering Transactions*, 70, 2077-2082 **(2018).** ISSN:2283-9216, https://doi.org/10.3303/CET1870347 , **SJR (Scopus): 0.273 , Q3 (Scopus)**

The present study aims at investigation of the liquid phase distribution in order to fill in the missing data on liquid spreading in industrial scale packing layer of metal Raschig Super-Ring (RSR) packings for development of a reliable prediction model. Our attempt to apply the well-proven dispersion model to RSR packings has faced difficulties connected with the packing open, web-like structure resulting in poor radial distribution properties and with the industrial scale of the packed column. An experimental set-up is designed so as to provide the necessary data for model parameters' identification. Special attention is paid to the uniform liquid distributor, in order to

ensure the validity of the model assumption of regular initial irrigation. The approach avoids the need of data from well-established wall flow, which can be measured at a very high (over 3 m in that scale) packing layer. Instead, it uses additional data from irrigation on the column wall, provided by a peripheral liquid distributor. The present work has obtained original data for the liquid distribution in RSR packings of different sizes addressing improvement and validation of a prediction model.

**5.** **Petrova, T.**, Semkov, K**,** Dzhonova-Atanasova, D., "Modeling of Liquid Distribution in a Packed Column with Open-structure Random Packings", *Chemical Engineering Transactions*, 70, 1051-1056 (2018). ISSN:2283-9216, https://doi.org/10.3303/CET1870176 , **SJR (Scopus):0.273, Q3 (Scopus)**

The scientific interest in the efficiency of packed bed columns is a part of the world-wide pursuit of sustainability of the processes. The maldistribution of the phases in the apparatus reduces the efficiency and makes difficult the prediction of process performance and scaling up. The present work aims at modeling of liquid distribution in a packed column with high performance open-structure random packings - metal Raschig Super-Rings 0.7", 1.5" and 3" and metal Pall rings 1". Some new approaches for estimation and calculation of model parameters are proposed and tested, using own experimental data for Raschig Super-Rings and published data for Pall rings. A new procedure for identifying one of the model parameters, called by us "overlapping confidential intervals" solution, is developed and illustrated for Raschig Super-Ring packing in the case of partial radial insensitivity ("plateau") of the residual variance between the model and experimental data. The obtained results show that using appropriate statistical methods of estimation, the dispersion model parameters can be successfully identified achieving a very good prediction of the experimental data. Several numerical examples and case studies are considered and discussed. For the case of Pall rings, the dispersion model predictions are in very good agreement with both published experimental data and predictions made by Computational Fluid Dynamics (CFD) modeling.

**6.** **T. S. Petrova**, D. B. Dzhonova-Atanasova, "Flow Simulation and Identification of Important Model Parameters in Industrial Packed Beds for High-Performance Random Packings", *Journal of Ecological Engineering*, 20, 9, 116-120 **(2019).** ISSN: 2299-8993, https://doi.org/10.12911/22998993/112500 , **SJR (Scopus):0.312 Q2 (Scopus)**

The goals of this work were: first, to simulate the liquid flow distribution in a large diameter (1.2 m) packed column with an RMSR 70-5 high performance random packing (layer height up to 3 m), by a dispersion model. Second, to find and estimate the important model parameters and flow maldistribution factor, using experimental data and two different optimization approaches. A three-parameter dispersion model for prediction of radial liquid distribution and two different approaches to determine some of the model parameters from experimental data were used. In

parallel, a two-parameter optimization procedure for model parameters identification was performed based on the minimum of residual variance between model and experimental liquid velocities over a column cross-section. The simulated and experimental flow maldistribution, were estimated by means of an integral estimation – a maldistribution factor. The comparison between the model and experimental liquid distribution and respective maldistribution factors at packing heights H = 1 m and H = 2.5 m for liquid load $16.6 \cdot 10^{-3}$ $m^3/m^2 \cdot s$ showed very good agreement, even for a high packing layer. In conclusion, the presented model predictions and estimations about RMSR 70-5 characteristics and behaviour will complement the information about its efficiency and operation in industrial processes.

**7.** **T. St. Petrova**, D. B. Dzhonova-Atanasova, "Simulation of the liquid distribution in the wall zone of a packed column: case study", *Bulgarian Chemical Communications*, 51, F, 91-98 **(2019)**. ISSN:0324-1130, http://bcc.bas.bg/BCC_Volumes/Volume_51_Special_F_2019/51F_SF_Pages.91-98.pdf, **SJR (Scopus):0.142 Q4 (Scopus)**

The maldistribution of the liquid phase in a packed column is essential for the efficiency of the mass transfer processes in it. One of the wide-spread methods to measure the liquid distribution in the packing layer includes liquid collecting device (LCD) mounted under the packed bed. The proper design of the LCD is very important for obtaining correct information about the hydrodynamics in the column. The most popular construction of LCD is composed of fixed number of concentric cylindrical sections, with equal or different cross-sectional surface areas. The number and width of these sections is determined so as to ensure enough resolution of the picture of the liquid flow. In this study an analysis and estimation of several variants for possible fragmentation of LCD are provided, based on a dispersion model simulations and calculation of the maldistribution factor. The simulation results are verified with experimental data for metal Raschig Super-Rings 1.5" (RSRM) with an improvement of the LCD. It is shown also, that model parameters identification depends on the LCD fragmentation, especially in the wall zone of the packed column. The present study defines a quantitative criterion for LCD design assessment, which is the fragmentation effect on the maldistribution factor. This solves the issue with the proper data collecting, necessary for obtaining the actual liquid distribution and for parameter identification of the dispersion model.

**8.** Kr. A. Semkov, **T. St. Petrova**, "New equations for gas phase pressure drop in expanded metal sheet packing (HOLPACK) for mass and heat transfer processes in packed columns", *Bulgarian Chemical Communications*, 52, Special Issue F, 80-85 **(2020)**. ISSN:0324-1130, DOI: 10.34049/bcc.52.F.0014, http://bcc.bas.bg/BCC_Volumes/Volume_52_Special_F_2020/BCC-52-F-2020-80-85-Semkov-14.pdf , **SJR (2020)=0.174, Q4 (Scopus)**

A horizontal expanded metal sheet packing is designed and investigated for carrying out mass and heat transfer processes in column apparatuses. The packing is made of expanded metal sheet

elements placed horizontally with specific orientation at certain distance from one another along the column height. This construction leads to low specific weight and creates condition for highly effective heat and mass transfer at comparatively low gas pressure drop. The packing is studied in details; mathematical models and dimensioning methodology of apparatuses are provided and tested. As a result, the packing was successfully implemented in many processes in the chemical and power industry, as well as in the environmental protection. After a careful critical analysis of the earlier models and equations for determination of the pressure drop of dry and irrigated packing, as well as of loading point gas velocity, some imperfections and, respectively, opportunities for substantial improvement were found. Subsequently, on the base of many years practical (incl. industrial) experience, three new dependences were developed, firstly presented in this work. For the new equations the same experimental data are used as in the old ones; the principal differences evolve from the more appropriate and well-founded structure of the new equations and the better estimation of the geometric dimensions. The proposed equations are derived using dimensional analysis and least squares approach regression. For each equation the main statistic parameters are given. The comparison with the experimental data is illustrated in appropriate diagrams. The accuracy of the new equations is substantially improved, offering a stable base for industrial design and further applications with best performance and energy characteristics.

**9.** **Tatyana Petrova**, Daniela B. Dzhonova-Atanasova**,** Krum A. Semkov, "Comparison of experimental and model liquid distribution in large packed bed of Raflux rings 50-5", IOP Conference Series: Materials Science and Engineering (MSE), 876, 012009 (5 pages) (2020). ISSN:1757-8981, E-ISSN:1757-899X, https://doi.org/10.1088/1757-899X/876/1/012009 , **SJR (2019) = 0.198 SJR, непопадащ в Q категория (Scopus)**

This work presents a continuation of our investigations on the radial liquid distribution in packed beds with open-structure random packings, by means of a dispersion model, in a scale, close to industrial one. Using experimental data for uniform initial irrigation, the optimal parameters' values of the three parameters of the dispersion model are obtained by two-parameter identification. One of the parameters (the radial spreading coefficient) is calculated independently by using experimental data for a point source initial irrigation. The dispersion model solution at optimal parameters' values is compared with both experimental and TUM WelChemCell model literature data for the liquid radial distribution in a packed column with a diameter of 1.2 m and random packing Raflux rings 50-5. The maldistribution factor of the liquid distribution is also calculated and compared. The comparison shows very good agreement between our results and the literature data and confirms the dispersion model capability to predict the liquid distribution in large columns with open-structure packings.

**10.** Becker, W., Valeva, V., **Petrova, T.,** Ivanova, J., "Technical damage in wind rotor blade under static load at environment conditions", *Chemical Engineering Transactions*, 42, 91-96 **(2014)**. ISSN:2283-9216, https://doi.org/10.3303/CET1442016, **SJR(2014)=0.425, Q2 (Scopus)**

Accidents with a wind rotor blade are frequently observed in the wind farms and the simulation study of its undesired damage and its full degradation has to be done. As usual, the full degradation of the wind rotor blade happens in a sequence of appearing first transitive (I mode crack) and then interface delamination (II mode crack) between the involved layers of a rotor blade laminate. The question of the risk value of the interface delamination is important for further reliability of wind blade to work safety.
In the present approach the unacceptable interface delamination in a pre-cracked (1st mode) bi-material structure as a part of the straight line of wind rotor blade under static mechanical, temperature, and electric loading and moisture will be considered. With this first step, the influence of environment conditions such as moisture and temperature as well as the properties of the bi-material plate will be assumed to be linear.
The investigation will be performed by using a simple 1D shear lag model of the unit cell of wind rotor blade. The electric voltage acting on the first piezoelectric plate of bi-material structure will be used as a sensor identifying the possible delamination between the layers. The material and physical properties of the structure are taken from literature. The obtained results are illustrated by figures and discussed. Some recommendations for safety work of the wind rotor blade as well as a criterion for identifying the interface delamination through the electric gradient will be proposed.

**11.** Ivanova, J., Valeva, V., **Petrova, T.**, Becker, W., "Interfacial debonding of a piezoelastic bi-material structure applicable for wind rotor blades", *Mechanics of Advanced Materials and Structures*, 22, 10, 813-818 **(2015)**. ISSN:1537-6494 print/1537-6532 online, https://doi.org/10.1080/15376494.2013.864433 , **IF (2015) =1.00, Q2 (Web of Science)**

The main goal of the article is to model the straight line part of a wind blade by an analytical 1D shear lag model in order to analyze and detect possible interface delamination through the change of the voltage along the interface. A unit cell presented by a bi-material structure consisting of a first piezoelastic layer and an elastic second layer under static mechanical and electric load is considered. Numerical examples are provided and illustrated by figures and discussed. A criterion for detecting the interface elastic-brittle delamination and a safety zone for combined electrical and static loading is proposed.

**12.** **Petrova, T.,** Kirilova, E., Becker, W., Vaklieva-Bancheva, N., Ivanova, J., "Optimal Analysis of Adhesive Lightweight Joints", *ZAMM - Journal of Applied Mathematics and Mechanics*, 96, 11, 1280-1290 **(2016)**. ISSN: 0044-2267 (print) / 1521-4001 (online), https://doi.org/10.1002/zamm.201600006 , **IF (2016)=1.332, Q2 (Web of Science)**

In the present paper the behavior of the piezoelectric response of smart lightweight structures consisting in a piezoelectric patch over a host layer under static load and affected by electrical load at environment conditions is studied. The shear lag analysis is applied to investigate the possible interface delamination and to calculate analytically the interface debond length. It has been demonstrated that the roots of respective characteristic equation play a leading role for place of the interface delamination in the overlap zone of the structure under consideration. This leads to the conditions for the actual deboning existence and opens the possibility of an optimal analysis. The proposed approach consists in involving the shear lag model in a global optimization framework where simultaneously the investigation of all model parameters can be carried out. The solution of that problem gives the values of the parameters at which a vanishing/minimal debond length is ensured. The efficiency of the proposed method is proved on three different examples as the optimal geometrical characteristics and effects ensuring no delamination in the structures are obtained.

**13.** Ivanova, J., Valeva, V., Yanakieva, A., **Petrova, T.,** Becker, W., "Damage of Bi-material Structures and Reinforced Composites with Different Industrial Applications", *Journal of Sustainable Development of Energy, Water and Environment Systems*, 4, 1, 23-37 **(2016)**. ISSN: 1848-9257 print/ 1848-9257 online, https://doi.org/10.13044/j.sdewes.2016.04.0003 , **SJR (2016)=0.355, Q2 (Scopus)**

The present paper consists of two parts. In the first part the interface delamination of bi-material structures (unit cell of wind rotor blade) with different material properties under mechanical loading at physical conditions – electricity, temperature and moisture is under consideration. The investigation of the above mentioned structures are motivated by the importance for safety of devices used for energy industry applications. The second part is devoted to renovation of old buildings by using new and modern composite materials. The goal is to find via mathematical modelling the safety zone, the reliability of the structures considered and the detection of possible interface delamination as a function of geometrical, material and physical parameters as well as the pull-out force of modern composites used in building industry. The analysis provided in both parts is based on the modified shear lag method. The results obtained in the first and second parts of the paper are illustrated by tables and figures. Some recommendations and possible criterions are proposed, as well.

**14.** Kirilova, E., **Petrova, T.,** Becker, W., Ivanova, J., "Influence of the geometry and the frequency range on the interface delamination in smart patch/layer structures under combined dynamic loading", *ZAMM - Journal of Applied Mathematics and Mechanics*, 97, 9, 1136-1146 **(2017)**. ISSN: 0044-2267 (print) / 1521-4001 (online), https://doi.org/10.1002/zamm.201600273 , **IF (2017)=1.296, Q2 (Web of Science)**

The paper deals with the interface behavior of a smart patch/layer lightweight structure subjected to combined time harmonic mechanical loading, electric field and environmental conditions. The

applied dynamic shear-lag and Fourier method refer to the overlap zone of the considered structure. It gives a possibility to obtain solutions in a closed form for axial and shear stresses of the structure. The types of solutions obtained depend mainly on the adherends' thickness, the frequency interval of applied dynamic loading and the shear modulus of the used adhesive. At a given constant ratio of thicknesses of the adherends, the frequency interval of the dynamic load can change drastically the type of solution of the considered system of ordinary differential equations.
Theoretical predictions for single debond length of patch/layer structure at an elastic-brittle interface behavior are provided. The influence of the ratio of thicknesses of the adherends in PZT-5H/CFRP patch/layer structure and the frequency range of applied dynamic mechanical loading on the interface delamination is investigated. All results are illustrated in figures and tables and are discussed.

**15.** Ivanova, J., **Petrova, T.,** Kirilova, E., Becker, W., "Optimal parameters of a dynamically loaded patch/layer structure against the elastic-brittle interface debonding", *Engineering Transactions*, 65, 1, 97-103, **(2017).** ISSN:0867-888X (Print) 2450-8071 (Online), https://et.ippt.pan.pl/index.php/et/article/view/697/651, **SJR(2017)=0.17 , Q3 (Scopus)**

A one-dimensional shear-lag model was developed to study the high frequency, dynamic, time-harmonic mechanical behavior of the overlap zone of a piezoelastic patch attached to an elastic host layer and subjected to electric, temperature and moisture excitation. It was interesting to see that the change of the geometry of the overlap zone leads to different solutions after some frequency, which is responsible for different dynamic behavior of the considered structure. Furthermore, the model was involved in an optimization framework (genetic algorithm-GA) in order to find the optimal values of the model parameters of the patch/layer configuration.

**16.** Elisaveta Kirilova, Natasha Vaklieva-Bancheva, Rayka Vladova, **Tatyana Petrova**, "Optimal products' portfolio design of a sustainable supply chain using different recipes for dairy products production", *Chemical Engineering Transactions*, 81, 61-66 **(2020)**. ISSN:2283-9216, https://www.aidic.it/cet/20/81/011.pdf , **SJR(2020)=0.274, Q3 (Scopus)**

This study proposes a deterministic optimization approach for products portfolio design of a Sustainable Supply Chain (SSC) comprising suppliers, plants and markets for production of dairy products using different recipes. It includes three interconnected models of the recipes used for the production of the dairy products, the SC design and the SC environmental impact. The latter is assessed in terms of wastewater and CO2 emissions associated with the dairy production and the transportation. The models are included in an optimization working frame along environmental and economic criteria. The proposed approach has been implemented on a case study from Bulgaria – for production of two types of curd at two recipes using two types of milk. Optimization problems have been formulated in terms of MINLP. They are solved at different imposed environmental pollution taxes on the dairies regarding both wastewater and CO2 emissions. The

optimal SC products portfolio for the production of the planned products is obtained satisfying the best trade-off between environmental and economic criteria.

**17.** Kirilova E.G., Vaklieva-Bancheva N.G., **Petrova T.S.,** Vladova R.K., Varbanov P.S., "A MINLP Model to Optimal Design of Sustainable Dairy Supply Chain Taking into Account Preferences of the Network Actors", *Chemical Engineering Transactions*, 88, 1045-1050, **(2021).** ISSN:2283-9216, https://www.cetjournal.it/cet/21/88/174.pdf , **SJR(2021)=0.25, Q3 (Scopus)**

The increase of pollutants generated in the production of dairy products, the increase of the production costs and emerging social problems requires the development of approaches for resilience improvement of the considered product productions. An effective way to achieve this is by optimising all activities across the supply chain: from milk suppliers through the production itself to end-users meeting environmental, economic and social criteria. The other important aspect of solving this type of problems is taking into account the preferences of all actors in the network. The present study proposes a mixed-integer non-linear programming (MINLP) model for the optimal design of a sustainable dairy supply chain (SC) for the production of different dairy products satisfying the preferences of all actors of the network - milk suppliers, dairies and markets. The approach includes models for the production of dairy products along with the economic, environmental and social impact of the considered SC. Three optimization problems are defined and solved at different optimisation criteria representing the preferences of all actors in the SC. The first solution results in the supply of 162,022 kg of two types of milk for the production of 61,758 kg of low and high-fat content products. The latter exceeds the market demands. This is the solution with the largest economic and social costs and lowest production profit of 118,008 BGN. The second solution is related to the production of 60,023 kg of both products. This is the solution with the lowest economic costs and largest production profit of 143,809 BGN. In solution 3, full satisfaction of market requirements was achieved. It is related to the supply of 132,146 kg of both types of milk for the production of 60,057 kg of both products.

**18.** Elisaveta Kirilova, Natasha Vaklieva-Bancheva, Rayka Vladova, **Tatyana Petrova**, Boyan Ivanov, Desislava Nikolova, Yunzile Dzhelil, "An approach for a sustainable decision-making in product portfolio design of dairy supply chain in terms of environmental, economic and social criteria", *Clean Technologies and Environmental Policy*, 24, 213–227 (2022). Electronic ISSN:1618-9558/Print ISSN: 1618-954X, https://doi.org/10.1007/s10098-021-02110-2 , **IF(2022)=4.3, Q1 (Scopus)**

The production of dairy products is related to water and energy costs and generation of large amounts of emissions of pollutants. Full sustainability of these systems can be achieved by optimizing all activities in the supply chain (SC) taking into account not only the environmental and economic aspects, but also the social ones. This study proposes a multi-objective modeling approach for optimal design of three-echelon SC for production of dairy products according to

different recipes while satisfying environmental, economic and social criteria defined in terms of costs. The environmental costs are associated with the generated wastewater from dairy production and CO2 emissions due to energy consumed and transport of raw materials and products. The social ones are related to the employees hired for implementation of the SC activities. It was implemented on a real case study from Bulgaria. Four mix integer nonlinear programming optimization models were defined–one without and three with social impact consideration. They were solved at different values of the environmental and social constraints. The obtain results showed that stricter environmental constraints lead to higher economic costs and lower profit. Conversely, higher environmental constraints result in higher profit and lower economic costs. The greatest share in the environmental impact has the wastewater generated, followed by CO2 emissions related with energy consumed and CO2 emissions due to transport. The obtained solutions can be used in the decision-making process in terms of seeking a trade-off between profit, environmental and social impact.

**19.** **T. Petrova**, E. Kirilova, W. Becker, J. Ivanova, "Two-dimensional Stress and strain Analysis for Graphene Polymer Nanocomposite under Axial Load", *Journal of Applied and Computational Mechanics*, 8(3), 1065-1075, **(2022)**. DOI: 10.22055/jacm.2022.38834.3292, ISSN: 2383-4536, https://jacm.scu.ac.ir/article_17375_df61b2d51bb1d86d74bd52c9557faefa.pdf, **IF(2022)=3.1, Q1 (Web of Science)**

A two-dimensional stress-function method describing the stress transfer in a three-layered adhesive bonded graphene and poly(methyl methacrylate) nanocomposite structure, subjected to axial load is developed and applied. The governing ordinary differential equation of fourth order with constant coefficients for the axial stress in the first layer is obtained minimizing the strain energy in the whole structure and solved analytically. The two-dimensional stresses and strains (axial, shear and peel) in the structure's layers are expressed and calculated as functions of this axial one and its derivatives and illustrated with graphics. The model graphene strain is compared with experimental data for strain in graphene and shear-lag model results from literature and shows good agreement at 0.4% external strains.

**20.** **T. Petrova**, E. Kirilova, W. Becker, J. Ivanova, "Influence of type of adhesive on the interface debonding of a $BaTiO_3$/Epoxy structure under time harmonic mechanical load and electric field at environmental conditions", *Journal of Theoretical and Applied Mechanics*, 52(4), 365-380 **(2022)**. Print ISSN: 0861-6663 (print), Online ISSN: 1314-8710, https://jtambg.eu/papers/2022/JTAM2022_4_365-380.pdf , **IF(2022)=0.2, Q4 (Web of Science)**

The study deals with investigation of the effect of the used adhesive upon the interface delamination at adhesively bonded piezoelectric patch/layer structure BaTiO3/Epoxy subjected to time harmonic mechanical load and electric field at environmental conditions. This is needed for

a prediction of conditions, at which these type of structures work safely (without failure). For the interface shear stress in the overlap zone of structure, at two different thicknesses of its adherends and three adhesives used, a solution method based on shear lag and Fourier method has been applied. The types of solutions obtained depend mainly on the adherends' thickness, the magnitude and frequency of the applied mechanical loading and the shear modulus of the used adhesive. Based on the analysis conducted it has been shown that with increasing magnitude and frequency of applied mechanical load, the delamination length also increased. The delamination could be avoided if the stronger adhesives and thicker adherends are chosen. The debond length is highly dependent on the magnitude of electric displacement. The analytical equation for resonant frequencies in the considered structure is developed on the base of obtained solutions and they are calculated at all three investigated adhesives.

**21.** Kirilova E.G., Vaklieva-Bancheva N.G., Vladova R.K., **Petrova T.S.,** Nikolova D.S., Ganev E.I., Dzhelil Y.R., "Impact of Product Demand uncertainties on the Optimal Design of a Sustainable Dairy Supply Chain: A Case Study of Bulgaria", *Chemical Engineering Transactions*, 94, 547-552 **(2022)**. ISSN:2283-9216, https://www.cetjournal.it/cet/22/94/091.pdf , **SJR(2022)=0.25, Q3 (Scopus)**

Population growth and income, together with urbanization, have caused a significant increase in demand for dairy products. This creates opportunities for increasing the profit from dairy production, but on the other hand, it is associated with the generation of large amounts of pollutants that are released into the air and water and require costs for their treatment and disposal. The presence of fluctuations in the product demands in the markets also influences the sustainable operation of considered supply chain (SC) activities. This study proposes a robust optimisation approach for handling the uncertainty of product demands in a dairy SC to produce different dairy products according to different recipes while satisfying environmental and economic criteria. The latter is associated with the generated wastewater from dairy production and CO2 emissions due to the energy consumed and transportation. The approach has been implemented in a real case study from Bulgaria. Deterministic and robust optimization problems have been formulated and solved under nominal data for the product demands and three different uncertainties levels – 0.2, 0.5 and 1. The obtained results show that the increase in the uncertainty level leads to decreasing profit from the dairy SC with a relatively small standard deviation. The lowest mean value of the SC profit of 232,882 BGN is obtained at the greatest uncertainty level of 1. The results for SC total costs show that they also do not change significantly with an increase in the uncertainty level. The largest value of 154,018 BGN has been obtained at an uncertainty level of 0.5. Given the latter, it can be said that the developed robust optimization model is a sustainable, which leads to obtaining results for the SC profit and costs that do not change significantly with an increase in the uncertainty level of consideration of product demands.

**22.** Rayka Vladova, **Tatyana Petrova**, Elisaveta Kirilova, Apostol Apostolov, Boyan Boyadjiev, "Comparison of the model axial graphene strain distributions in graphene/epoxy/polymethyl methacrylate (PMMA) nanocomposite under mechanical and thermomechanical loading", *Bulgarian Chemical Communications*, 54, 4, 349-354 **(2022)**. ISSN:0324-1130, DOI:10.34049/bcc.54.4.5539, http://www.bcc.bas.bg/BCC_Volumes/Volume_54_Number_4_2022/bcc-54-4-2022-349-354-vladova-5539.pdf , **SJR (Scopus):0.168, Q4 (Scopus)**

The current report presents a theoretical study of the application of a two-dimensional stress-function method to analytically describe and compare the strains in graphene/epoxy/polymethyl methacrylate (PMMA) nanocomposite structure under three types of loading - mechanical, thermal and thermo-mechanical. Respectively, three model case solutions for all 2D strains in the nanocomposite layers at different cases of loading are developed, considered and compared with each other to illustrate the temperature influence on the strains. All results for the behavior of the axial, peel and shear strains for all three layers of the structure are illustrated in figures and discussed. The model axial strain in the graphene layer at two different mechanical external strains - 0.3% and 0.8%, was compared and validated with experimental data at mechanical loading. The obtained results could be used for fast prediction of strain distributions in similar nanocomposite devices as sensors, nano- and optical electronic devices, energy devices, etc., at different types of external loadings.

**23.** **Tatyana Petrova**, Elisaveta Kirilova, Rayka Vladova, Boyan Boyadjiev, Wilfried Becker, Petia Dineva-Vladikova, "Modelling and validation of the axial strain distribution in WS2 flakes at WS2/Epoxy/PMMA nanocomposite under axial load", *U. Porto Journal of Engineering,* 8, 6, 160-169, **(2022)**. ISSN:2183-6493, https://journalengineering.fe.up.pt/index.php/upjeng/article/view/2183-6493_008-006_0011/708 , **SJR (Scopus):0.15 , Q4 (Scopus)**

In the present study, a two-dimensional stress-function method is applied to model the axial strain distribution in the tungsten disulfide ($WS_2$) flake embedded in an epoxy/polymethyl methacrylate nanocomposite structure subjected to an axial tension load. The analytical model strain distribution along the flake is calculated and compared with experimental and shear-lag model literature data for monolayer flake at an external strain of 0.35% and 0.55%, as well as with results for few-layer flakes at an external strain of 0.55%. The comparison shows good agreement and confirms the applicability of our model method for describing strains in nanocomposite layered structures in the elastic region of applied loads. The presented method is not appropriate for few layers flake at an external strain of 0.55% because of the appearance of relaxation zone and the formation of wrinkles in the flake.

**24.** Даниела Джонова-Атанасова, Константина Стефанова, Крум Семков, **Татяна Петрова,** Светослав Наков. Глава I. Експериментално изследване на неравномерността на течната фаза в колонни апарати с високоефективни ненаредени пълнежи. "Устойчиви процеси, устойчиви системи, устойчива околна среда", Издателство на БАН "Проф. Марин Дринов", 2020, ISBN:978-619-245-056-4, 17-43 Линк

In Chapter 1, experimental studies are described to measure the radial distribution of a liquid phase (water) after a layer of packing in a column with a diameter of 0.47 m and Raschig Super-Ring packings (RSRM) – 0.7″, 1.5″ and 3″, as well and plastic Raschig Super-Ring sizes 0.6″ and 2″ (RSRP) and Ralu-Flow sizes 1 and 2 (25 and 50 mm). The investigations were carried out for flow rates Qu0 = 1.87–7.49 m3/h at uniform initial loading and for Q0w = 0.3–0.6 m3/h at wall loading. The non-uniformity of the flows at the inlet and in depth of the column packing layer is also investigated and evaluated. Areas in the column with large-scale maldistribution are identified and solutions are proposed for describing and evaluating it.

**25.** **Татяна Петрова**, Даниела Джонова-Атанасова, Крум Семков. Глава II. Математическо моделиране на процесите на неравномерност на течната фаза в колони с пълнеж, методи за идентификация на моделните параметри, методи за определяне на оптимален дизайн на устройствата в проблемните зони. "Устойчиви процеси, устойчиви системи, устойчива околна среда", Издателство на БАН "Проф. Марин Дринов", 2020, ISBN:978-619-245-056-4, 44-86 Линк

In the present chapter, the possibilities of the dispersion model for the modeling of the radial distribution of the liquid phase after a layer of packing with an open structure are presented. The parameters of the model are analyzed and methods are proposed for their determination in different situations depending on the available experimental data and the conditions under which they were obtained. The assessment of the maldistribution of the liquid phase is represented quantitatively by the integral characteristic - maldistribution factor. The problem areas in the pilot plant, which are potential sources of maldistribution - the sprinkler (above the packing) and the liquid collection device (LCD) (below the packing) - were identified, and constructive changes in their design were proposed, which significantly reduce the non-uniformity. The hypothesis of the influence of the fragmentation of the LCD sections in the column wall zone on the identification of the parameters of the dispersion model was formulated and proved. Various variants of fragmentation of the LCD sections in the wall zone were simulated, a quantitative one was also selected criterion for determining the optimal design.

The verification of the dispersion model, of the methods of identification of its parameters and of the selection of the optimal design of the LCD, as well as of quantitative estimates of the maldistribution of the liquid phase was successfully carried out with our own (RSRM 0.7, 1.5 and 3″) and literature data. Most of the literature data are mainly experimental and, in some cases, model data are used, obtained for columns of semi-industrial and industrial size (0.6 m and 1.2 m) and random packings with an open structure (25 mm metal Pall rings (Yin, 1999); RMSR 70-5

and Raflux rings 50-5 (Hanusch et al., 2018a, 2019). The applicability of the dispersion model for modeling the radial distribution of liquid phase in second, third and fourth generation open structure packed columns for both semi-industrial and industrial columns is demonstrated. The ability of the dispersion model to simulate different types of maldistribution and in combination with the maldistribution factor – the possibility of optimization and evaluation of problem areas in the column has also been confirmed.